Appendix C – Benefits Assumptions

This appendix has been added to provide additional information related to Program Benefits (see section 2.0).

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Modeling of the Fuel Cycle Analysis

The total fuel cycle analysis including the environmental analysis was conducted using the GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) model, developed by the Center for Transportation Research at Argonne National Laboratory for the U.S. Department of Energy (see http://www.transportation.anl.gov/greet/index.html).

Modeling of the Oil Savings Benefit from Fuel Cell Vehicles

The President's Hydrogen Fuel Initiative states that light duty fuel cell vehicles (FCVs) could save over 11 million barrels of oil per day (mmb/d) by 2040. This reduction in oil demand is relative to the oil that light duty conventional vehicles (CVs) might otherwise consume in 2040. The estimate was developed using the VISION model. This model was developed by DOE to provide estimates of the potential energy use, oil use and carbon emission impacts through 2050 of advanced light- and heavy-duty highway vehicle technologies and alternative fuels. VISION was used instead of the Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) in part because NEMS only provides such estimates to 2025. Further, NEMS market penetration estimates themselves require projections of fuel prices, vehicle costs, and vehicle attributes. The prediction of fuel prices beyond 2025 is extremely uncertain, while predictions of H_2 FCV vehicle cost and attributes would be premature this early in the program, since yet to be discovered technical and cost breakthroughs are the goal of the program.

The VISION model consists of two Excel workbooks: one a Base Case of US highway fuel use and carbon emissions to 2050 and another a copy of the Base Case which can be modified to reflect alternative assumptions about advanced vehicle and alternative fuel market penetration. Oil savings estimates that are derived using this model are thus based on a number of assumptions about advanced vehicle (e.g., FCV) penetration, energy efficiency and resource fuel as well as assumptions about Base Case vehicle oil use which in turn is dependent on vehicle fuel, efficiency and travel.

A number of key modeling assumptions lead to the oil savings estimate calculated. They are as follows:

1) VISION uses EIA projections as much as possible in its Base Case. At this time, VISION uses the projections contained in EIA's Annual Energy Outlook (AEO) 2002. EIA has subsequently released AEO 2003 that actually implies higher oil use by light-duty vehicles (LDVs). VISION is being updated to incorporate these latter estimates, but the VISION results discussed here are based on AEO 2002 estimates.

2) The certification test fuel economy of new gasoline-fueled CVs in the Base Case is fixed at 28.5 MPG for cars and 21.2 MPG for light trucks throughout the analysis period. This assumption differs from EIA's latest projections of slight improvements in the fuel economy of gasoline-fueled CVs. In AEO 2003 EIA projects an 8% increase (total) in new gasoline light truck mpg between 2002 and 2025 and a 4% increase for new gasoline cars. VISION uses a fixed MPG Base Case because many analyses want to evaluate the effects of new technology penetration relative to existing technology.

3) All of the CVs in the Base Case are gasoline-fueled. Again this differs from EIA's AEO 2003 projections. By 2025, EIA projects that 17% of all LDVs sold in that year will be in a category defined by EIA as alternative fuel vehicles (AFVs). Though present hybrid electric vehicles run on gasoline and most, if not all, future hybrid electric vehicles will likely also run on gasoline, EIA nevertheless includes hybrid vehicles in its accounting of AFVs. Over 90% of EIA's AFVs will be hybrid electric and ethanol flex fuel vehicles, both of which will or can use gasoline (or diesel in the case of diesel hybrids). Only 0.04% would be FCVs. Again, the Base Case in VISION assumes 100% gasoline CVs in the future in order to evaluate the effects of new technology penetration relative to the predominant existing technology.

4) VISION includes Class 2b trucks (8,500 –10,000 lbs GVW) in its estimates of LDV fuel use. EIA does not.

5) The annual VMT per LDV in VISION is based on EIA's AEO 2002 vehicle-miles traveled (VMT) estimates extended to 2050. In VISION, average LDV VMT rises from 12,200 in 2002 to 13,859 in 2020, then to 14,737 in 2040, and finally to 15,000 by 2050. Cars and light trucks are used differently but by 2030 their average annual VMT is quite similar. EIA's AEO 2003 VMT estimates differ from its AEO 2002 estimates.

6) The energy efficiency of FCVs relative to current technology CVs is substantial, but also much debated. A future FCV is likely to be two to three times as energy efficient as a current technology CV. In the VISION run used to develop the oil savings estimate for the FreedomCAR and Fuel Partnership, the relative energy efficiency of FCVs was assumed to a) be 2.25 in 2018 through 2020, b) increase linearly to 2.5 by 2030 and c) remain there until 2040. We assumed that a FCV's relative energy efficiency would eventually reach 3.0, but not until post-2040.

7) When FCVs might be mass marketed is not known. But in this case it is assumed that FCVs would begin to be sold in substantial numbers in 2018 and reach 52.2% of LDV sales in 2025. The specific penetration rates that were assumed are 4% in 2018, 27% in 2020, 52% in 2025, 78% in 2030 and 100% in 2038, with linear interpolation generally used for intervening years. Hydrogen supplies are assumed to be available to facilitate this market penetration level.

8) The FCVs do not use petroleum (i.e., on-board reforming of gasoline is not assumed). The H_2 used by the FCVs is produced from natural gas or zero-carbon fuels.

Given the assumptions listed above, use of H_2 FCVs was estimated with the VISION model to generate an oil savings of 11.6 mmb/d in the light-duty transportation sector in 2040. Such a substantial savings in oil consumption would likely lead to lower oil prices than would otherwise occur. If world oil supplies are depleted within the time frame of the scenario, the hydrogen switch might be timely in preventing very high oil prices. If oil is abundant in that time frame, then energy security would be provided for the U.S., but oil might be used to a greater extent elsewhere in the world. VISION does not in any way evaluate interactions of world oil prices and oil demand.